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Aerial Surveys for Sea Turtles in Southern Georgia Waters, June 1991

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AERIAL SURVEYS FOR SEA TURTLES IN SOUTHERN GEORGIA WATERS, JUNE, 1991.—All sea turtle species occurring in U.S. waters are protected under the Endangered Species Act of 1973 (PL93-205). Under Section 7 of the Endangered Species Act, all Federal agencies must ensure that their actions do not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of critical habitats. Necropsies suggested that at least nine of the 93 sea turtles involved in a major sea turtle stranding event in spring 1991 along coastal Georgia had been impacted by U.S. Army Corps of Engineers (USACOE) hopper dredging activities in the Brunswick River Entrance Channel.[1] In addition, observers onboard dredges working in the channel documented 23 sea turtle takes during late March until early June, including one critically endangered Kemp's ridley (*Lepidochelys kempii*). As a result of this stranding event and the unusually high number of incidents involving sea turtles during the first 5 weeks of the dredging project, the USACOE requested that we utilize aerial reconnaissance to document the distribution and relative abundance of turtles in the vicinity of the Brunswick River Entrance Channel.

Aerial surveys for sea turtles in the western North Atlantic have been conducted in coastal waters from Nova Scotia to Key West and the Gulf of Mexico, and in the Chesapeake Bay and the Pamlico-Albemarle Estuarine Complex (Fritts et al. 1983; Thompson[2]; Keinath et al. 1987; Schroeder and Thompson 1987; Lohoefener et al. 1990; Thompson et al. 1991; Shoop and Kenney 1992; Epperly et al. 1995a,b). Although differences in environmental factors exist among surveyed areas, one which may affect the sightability of turtles is turbidity. Thompson et al. (1991) theorized that a lack of contrasting carapace coloration reduced the number of green (*Chelonia mydas*) and Kemp's ridley sea turtle sightings in the Gulf of Mexico aerial surveys. Thus, turbid waters may reduce the ability to sight sea turtles because of a diminished contrast of the carapace against the water's surface. We tested the feasibility of utilizing aerial surveys as a means to identify areas of high sea turtle abundance in relatively turbid inshore waters of the southeastern U.S. and determined the distribution and relative abundance of sea turtles in southern Georgia waters.

Methods.—We employed aerial survey methods similar to those used for surveys of inshore North Carolina waters (Epperly et al. 1995a). Estuarine and nearshore waters between 30°42.0′N and 31°11.5′N were divided into 12 strata based on geography (Table 1, Fig. 1). Areas of each stratum ranged from 9–84 km^2. Survey coverage averaged 31% in the inshore strata, and 14% in the offshore strata, with the exception of St. Simons Sound, St. Andrew Sound, and St. Mary's Entrance, where coverage averaged 26%. Surveys were conducted daily from 2–9 June, 1991 between 0745 and 1430 hours EST as weather permitted and lasted 7–35 minutes, depending on the size of the stratum. Surveys extended south of the Bruns-

[1] Slay, C. K. 1991. Endangered species observer program, Brunswick Ship Channel, April 1-June 19, 1991. Final Report to U.S. Army Corps of Engineers, Planning Division, Environmental, Savannah District, 100 West Oglethorpe Avenue, Savannah, Georgia 31402-0889. 7p.

[2] Thompson, N. B. 1984. Progress report on estimating density and abundance of marine turtles: results of first year pelagic surveys in the southeast U.S. Unpublished report. National Marine Fisheries Service, Miami, Florida. 60 p.

TABLE 1. Strip transect estimated number and density of sea turtles on the surface of southern Georgia waters, June, 1991. Area of each stratum is indicated in parenthesis.

Survey	Number of turtles sighted within stratum surveyed[a]	Total distance surveyed (km)	Estimated number of turtles on surface of stratum		Estimated density of turtles on surface of stratum	
			Number	Std. error of mean	Turtle/100 km^2	Std. error of mean
			Inshore strata			
Mackay R./Frederica R. (9 km^2)						
June 2	0	10	0	—	0	—
June 3	0	13	0	—	0	—
June 4	1	10	2.95	2.14	34.50	27.18
June 5	0	10	0	—	0	—
June 8	0	10	0	—	0	—
June 9	0	10	0	—	0	—
Brunswick R./Turtle R. (25 km^2)						
June 2	3	33	2.51	1.64	9.99	6.65
June 3	2	27	3.05	1.92	12.13	8.72
June 5	0	30	0	—	0	—
June 8	2	30	0	—	0	—
June 9	0	30	0	—	0	—
Jekyll So. (12 km^2)						
June 2	3	10	7.41	2.43	62.02	22.62
June 3	3	13	6.64	4.95	55.57	41.27
June 4	0	10	0	—	0	—
June 5	0	10	0	—	0	—
June 8	0	13	0	—	0	—
June 9	0	10	0	—	0	—
Satilla R. (25 km^2)						
June 2	0	20	0	—	0	—
June 3	0	20	0	—	0	—
June 4	0	17	0	—	0	—
Cumberland R. (15 km^2)						
June 2	0	17	0	—	0	—
June 3	0	17	0	—	0	—
June 4	0	17	0	—	0	—
Kings Bay/Cumberland So./St. Marys R. (22 km^2)						
June 2	0	20	0	—	0	—
June 3	0	27	0	—	0	—
June 4	0	27	0	—	0	—
			Offshore Strata			
St. Simons So. (53 km^2)						
June 3	0	33	0	—	0	—
June 4	0	33	0	—	0	—
Offshore #1 (33 km^2)						
June 3	0	13	0	—	0	—
June 4	0	17	0	—	0	—
St. Andrew So. (54 km^2)						
June 3	0	60	0	—	0	—
June 4	1	53	3.48	2.68	6.41	5.42
Offshore #2 (84 km^2)						
June 3	0	40	0	—	0	—
June 4	2	37	7.55	6.24	9.00	8.48

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TABLE 1. Continued.

Survey	Number of turtles sighted within stratum surveyed[a]	Total distance surveyed (km)	Estimated number of turtles on surface of stratum		Estimated density of turtles on surface of stratum	
			Number	Std. error of mean	Turtle/100 km²	Std. error of mean
Offshore #3 (58 km²)						
June 3	0	30	0	—	0	—
June 4	0	23	0	—	0	—
St. Marys Entrance (25 km²)						
June 3	1	23	3.35	2.42	13.44	10.84
June 4	1	23	0	—	0	—

[a] All turtles sighted, including those censored in calculations of density.

wick, Ga. area to enable comparison between locations. These locations included areas where turtles had been documented previously (Richardson 1990), areas where turtles caught in concurrent channel trawling[3] were being relocated, and nearshore ocean areas. Offshore surveys included three channel areas: two maintained by dredge (Brunswick River Entrance Channel and St. Mary's Entrance) and one natural (Jekyll Sound).

Each survey was a systematic sample of its respective study area: starting transects for each survey were randomly chosen from all possible transects in the survey, and each survey was systematically sampled northward or southward. Transects ran east-west to minimize glare and provide good viewing conditions, and were spaced at equal distances from the starting transect. Based on the maximum known swimming speed of loggerhead (*Caretta caretta*) sea turtles (6 km/hr, Keinath 1993), we chose a minimum distance between transects such that a turtle could not be sighted twice during any one survey. Thus, transects were spaced farther apart in offshore strata, where transect lengths were greater, than in the majority of inshore strata, where transect lengths were less. Surveys were conducted in a Cessna 172 (side-viewing platform) flying at a ground speed of 128 km/hr and an altitude of 152 m. Surveys were flown only if sea states were less than Beaufort Scale 3. Two observers surveyed a strip 150–300 m from either side of the flight line. This width was chosen based on perpendicular sighting distances derived from aerial surveys of the Pamlico-Albemarle Estuarine Complex using a similar platform (Epperly et al. 1995a). Turtles sighted outside this strip were not included in analysis. Turtle numbers and densities and the variances of these estimators were derived following methods of Epperly et al. (1995a). Surface density estimates were not adjusted to account for submerged turtles.

[3] Nelson, D. A., D. D. Dickerson, J. Richardson, and K. Reine. 1991. Sea turtle trawling survey associated with hopper dredging at Brunswick, Ga. Unpublished report. USACOE Waterways Experiment Station, Vicksburg, Miss. 254 p.

Results and discussion.—Repetitive aerial surveys of southern Georgia waters identified concentrations of sea turtles in the vicinity of the Brunswick River/St. Simons Sound and Jekyll Sound/St. Andrew Sound. Nineteen loggerhead and other cheloniid turtles were sighted on the surface during two complete offshore strata and three complete inshore strata surveys, and during three additional surveys of the northern inshore strata only (Table 1, Fig. 1). Surface densities ranged from 0 to 62.02 turtles/100 km² (Table 1). Coefficients of variation were high, ranging from 36–94%. Most turtles were sighted in the Brunswick River/Turtle River and the Jekyll Sound strata; none were sighted in the three southern inshore strata. Average density was highest in Jekyll Sound, a stratum without a maintained channel. In strata where maintained channels existed, turtles generally were sighted near the channels (Fig. 1).

Turtle sightings were corroborated by results of concurrent sampling in the area. Between May 26 and June 20, 23 sea turtles were taken by hopper dredges and 71 sea turtles were captured by fishing trawler under contract to the USACOE, in the Brunswick River Entrance Channel (Table 2). Eighteen turtles taken by trawler during the period of aerial surveys were relocated to Jekyll Sound[3]. This is one explanation for relatively high density estimates in Jekyll Sound from aerial surveys. All trawler-captured turtles were flipper-tagged prior to

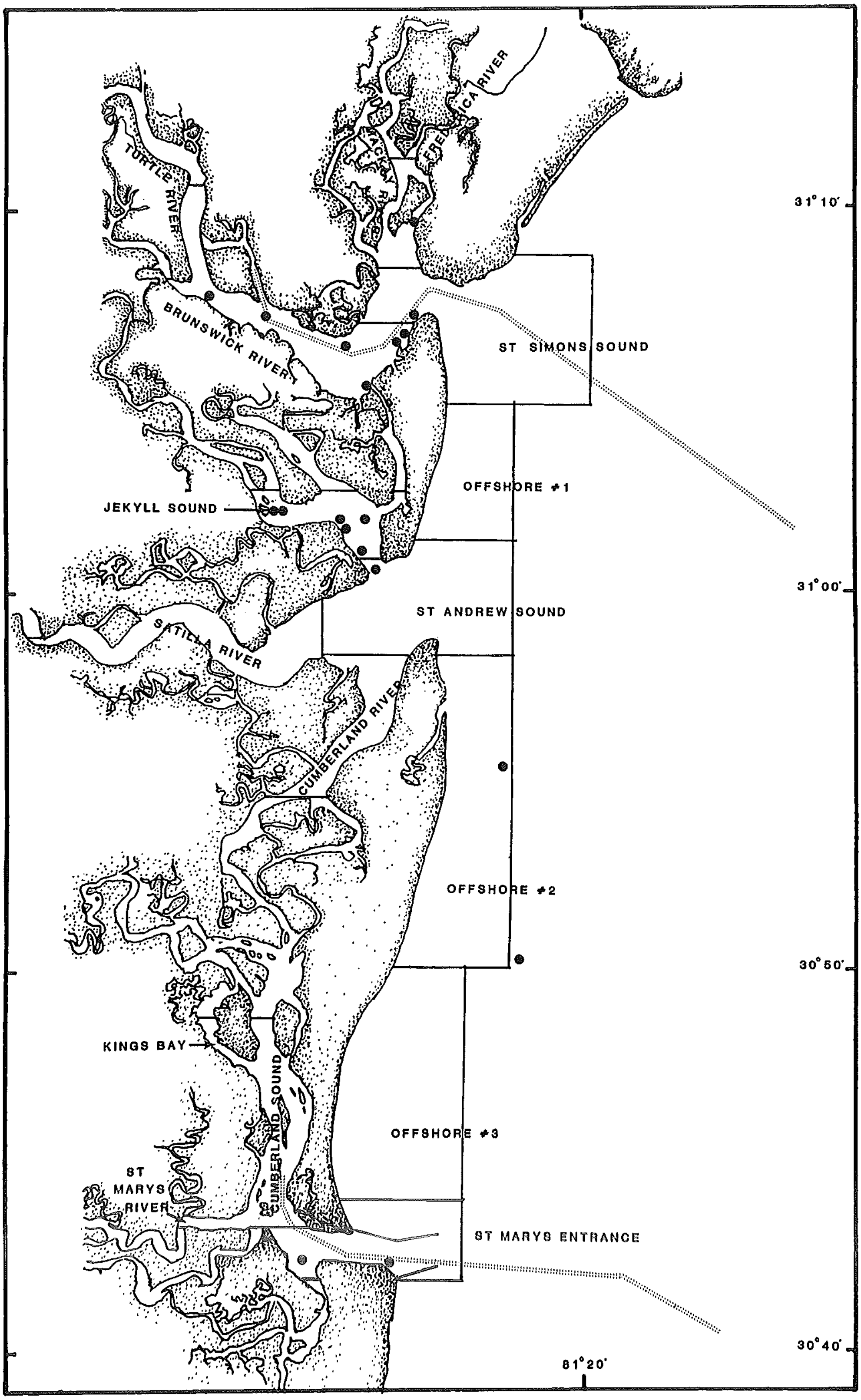

Fig. 1. Survey strata of the estuarine and nearshore waters of southern Georgia. Solid dots represent sea turtle sightings. Dashed lines represent maintained channels.

TABLE 2. Sea turtles captured by trawl in the Brunswick River Entrance Channel, Georgia, May 26–June 20, 1991.[1]

Date	Species: *Caretta caretta*	Species: *Lepidochelys kempii*
May 26–June 1	14	
June 2	2	
June 3	4	
June 4	3	
June 5	1	
June 6	2	
June 7	2	
June 8	2	
June 9	3	1
June 10–June 20	36	1

[1] Nelson, D. A., D. D. Dickerson, J. Richardson, and K. Reine. 1991. Sea turtle trawling survey associated with hopper dredging at Brunswick, Ga., Unpublished report. USACOE Waterways Experiment Station, Vicksburg, Miss. 254 p.

relocation and none were recaptured, suggesting that turtles were not returning to the Brunswick Channel.

Based on aerial survey data of the St. Simons Sound stratum, an area in which concurrent hopper dredging was occurring, and survey data of the Mackay, Frederica, Turtle and Brunswick Rivers, areas inshore of the dredging activity, we estimated a maximum abundance of 6 turtles on the surface (3 in the Mackay/Frederica River stratum, 3 in the Brunswick/Turtle River stratum and 0 in St. Simons Sound). This number may represent 4–41% of the total (surface and submerged) turtle population based on the percentage of time sea turtles are estimated to spend on the surface (Kemmerer et al. 1983; Byles and Dodd 1989). Our maximum density estimates of 34.50 turtles/100 km^2 for the Mackay River/Frederica River stratum, 12.13 turtles/100 km^2 for the Brunswick River/Turtle River stratum and 62.02 turtles/100 km^2 for Jekyll Sound (Table 1) were comparable to reported densities for other estuarine waters of the western North Atlantic obtained from aerial surveys (Keinath et al. 1987; Epperly et al. 1995a).

We demonstrated that aerial surveys are a feasible method to identify areas of relatively high sea turtle abundance, even in turbid, inshore waters. Sighting a sea turtle on the surface is a rare event, even in areas of relatively high abundance; hence, variances for the estimates of number and density are high. Despite this variability, repetitive surveys of the Brunswick River channel (five in Brunswick River, two in St. Simon Sound) revealed an apparent association of sea turtles with the channel. We conclude that information derived from region-wide surveys could be used in formulating management strategies for the protection of these endangered and threatened species. For example, areas and times where turtle-dredge encounters are likely could be identified. These data would allow the State and Federal agencies to afford site specific protection to turtles while they are vulnerable to hopper dredges. Results of more intensive monitoring efforts could allow the definition of dredging windows which would minimize the impact on sea turtles and still allow adequate maintenance of navigation channels.

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FIRST OBSERVATIONS OF YOUNG-OF-YEAR GULF OF MEXICO STURGEON (*ACIPENSER OXYRINCHUS DE SOTOI*) IN THE SUWANNEE RIVER, FLORIDA.—Gulf of Mexico sturgeon, *Acipenser oxyrinchus de sotoi* (sometimes referred to as Gulf sturgeon), is an anadromous species with spawning migrations into rivers occurring primarily from late Feb. to early May (Huff, 1975; Wooley and Crateau, 1982; Chapman and Carr, 1995). The adult sturgeon remain in the river until the fall, when they migrate into the Gulf of Mexico (Huff, 1975; Wooley and Crateau, 1982).

Previous investigators have been unable to locate the spawning grounds of Gulf of Mexico sturgeon or to determine where young fish venture after they hatch. During early May, a single collection of 1–2-day-old-larvae was made by Wooley et al. (1982) working upstream in the Apalachicola River in northwest Florida. In the Suwannee River, primarily at the river's mouth, juvenile sturgeon [60–70 cm in total length (TL), 0.5–2.5 kg] are commonly captured during winter and spring; the smallest individual collected during this time was 42 cm TL and 300 g in body weight (J. P. Clugston, National Biological Service, pers. comm.).

The Gulf of Mexico sturgeon is federally protected as a threatened species (Federal Register, 1991). A mandate for sturgeon recovery is to identify essential habitats important to each developmental life stage of the species. In this study, we report the first observation of young-of-year sturgeon in the upper reaches of the Suwannee River.

Materials and Methods.—We attempted to locate Gulf of Mexico sturgeon around aquifer springs that naturally seep into the Suwannee River (DER, 1985). We believe river areas in close proximity to springs are likely spawning sites for Gulf of Mexico sturgeon. Sturgeon require hard bottom substrates to deposit their eggs (Doroshov, 1985). Suwannee River natural spring areas are known to consist primarily of deep trenches and outcroppings of hard limestone (Rosenau et al., 1977). In addition, Chapman and Carr (1995) indicated that cool water temperatures (15–22 C) are necessary for optimal spawning and larval survival of Gulf of Mexico sturgeon. Water temperatures of the Suwannee River springs are stable at around 18–21 C (Rosenau et al., 1977), and adult sturgeon are often found in proximity to these springs (Chapman and Carr, 1995).

Sturgeon were captured with a dip net. The fish were also collected by hand by snorkeling divers. The term young-of-year (YOY) refers to juvenile sturgeon from 1 month to approximately 1 year in age (July 1). Fish were measured (TL in cm) and weighed (g) using a measuring tape and balance. Approximate sizes of sturgeon in the water were estimated from video and photographs taken at the site. Water temperatures were taken approximately 6 cm above the river bottom.

Results and discussion.—The number and body sizes of young Gulf of Mexico sturgeon ob-

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